



## Some Clicker Questions - #1

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$$\Delta x \Delta p \geq \frac{h}{4\pi}$$

What is the meaning of Heisenberg's Uncertainty Principle

- A) Space and time are combined into a 4 dimensional space-time
- B) Small objects have a wave function
- C) It is not possible to know the exact position and momentum of an object at the same time**
- D) It is not possible to ever know the exact position of an object
- E) It is not possible to ever know the exact momentum of an object



## Some Clicker Questions - #2

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$$\Delta x \Delta p \geq \frac{h}{4\pi}$$

For this problem assume that  $h=1$ .  $\pi = 3.1415$

Suppose that the position is known to  $(1/4\pi)$  m.

$$\Delta x = (1/4\pi) \text{ m}$$

What is the minimum uncertainty in velocity for a 1 kg particle? Recall: momentum = mass x velocity

- A) 1 m/s    B) 3 m/s    C) 4.5 m/s    D) 7 m/s    E) 9 m/s



## Some Clicker Questions - #3

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In the previous problem, the uncertainty in velocity was 1 m/s. In 1000 s (16.7 min), what is the uncertainty in position resulting from this uncertainty in velocity? Recall: distance = velocity x time, and

Uncertainty in distance = (uncertainty in velocity) x time

- A) **1 km**    B)  $\pi$  km    C) 5 km    D) 100 m    E) 10 m

On the homework you will have to use the real value for  $h$  and real masses, etc.